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Use of 13C enriched CO_2 to determine soil respiration rates in vegetated topsoil and subsoil exposed to surface conditions

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Subsoils are receiving significant attention in the current context of climatic change, because of their carbon (C) sequestration potential. Subsoils are C-depleted compared to topsoils, and are now seen as a potential C sink, but C dynamics and processes in subsoils are still largely unexplored. During quarry excavation, or the construction of infrastructures (e.g. roads and railways), subsoils are often moved to the surface and then vegetated. This is the case, for example, of road embankments or quarries that undergo a process of land restoration via re-vegetation. Therefore, it is important to understand how the use of subsoil influences C cycling. Subsoils differ from topsoils with regard to key factors that can influence C cycling, such as fertility, soil weathering levels, microbiological diversity/activity and C saturation levels. These factors will influence how soils sequester C, as well as how it is consumed and released in the atmosphere through respired CO_2. With regard to soil respiration, the use of subsoil could induce a strong priming effect, since the input of fresh organic matter will boost the microbiological activity of the soil and possibly increase the degradation and consumption of pre-existent C. This aspect of vegetating excavated subsoil and the comparison with topsoil has rarely been studied. Therefore, we have carried out an experiment at the Ecotron (http://www.ecotron.cnrs.fr/) microcosm facilities using isotope labeling techniques. Three continuously labeled chambers with 13C enriched CO_2 were used to grow two plant species: Medicago sativa and Plantago lanceolata, both of which are routinely planted on road embankments. The two species were grown in pots with two soil horizons: i) organic topsoil and ii) mineral subsoil. Bare soil was used as a control. The soils originated from the same clay soil profile in Pisciotta (Italy), and were taken at different depths: 0-30 cm for topsoil and 120-150 cm for subsoil. Labeled air was continuously infused in the growth chambers for 6 months. Every two weeks, soil respiration was measured and analyses were run for CO_2 concentration and 13C abundance. The results revealed lower respiration rates in vegetated subsoil compared to topsoil. The priming effect of vegetated subsoil was present, but it was surprisingly low compared to that observed in the topsoil. In addition, the 13C signal was lower for the subsoil, suggesting a higher share of previously stored C utilized by microorganisms. This effect might be due to differences in microbiological communities that can be found in the soil layers. Future work will be focused on analyzing the C stored in soil and the evolution of the microbiological community in the two soils.